Enhancing operational drought monitoring and prediction products through synthesis of N-LDAS and CPPA research results

YEAR 2 PROGRESS REPORT

NOAA Award: NA10OAR4310245

University of Washington
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This is a joint project with Princeton University (E.F. Wood, PI). NOAA has made separate awards to the two institutions, which therefore report separately. The tasks are nonetheless coordinated between the two institutions. We indicate the lead institution, and where Princeton is the lead but UW has played a role, the contribution of UW during the reporting period, which is the first year of the subject project.

Task 1: Transition Bayesian seasonal ensemble forecast system to the CTB (**Lead: PU**)

We proposed to transition to the CTB the Princeton Bayesian merging algorithm, and the three forecast sources that have been demonstrated off-line (CFS, ESP, and the ensemble version of the CPC "official" forecasts as implemented in the University of Washington's west-wide forecast system).

Status: Princeton University is the lead for this task; UW does not have a major role.

Task 2: **Integration of systems to provide objective drought indices (Lead PU)**

The intent of this task is to integrate the three existing systems (Princeton, University of Washington, and EMC) have slightly different elements; a subset of those elements that is most appropriate for operational purposes. For instance, the existing EMC system uses Noah, Sac, VIC, and Mosaic; the Princeton system uses only VIC, whereas the University of Washington system uses VIC, Noah, Sac, and CLM (Community Land Model). Also, the University of Washington has implemented NASA/GSFC's Catchment LSM (essentially the successor to Mosaic) within the UW multimodel system, and we will (with agreement of our NASA/GSFC colleagues) transition Catchment to the CTB system when testing is complete. Furthermore, UW is in the process of implementing the Unified Land Model (ULM; a merger of the Noah and Sacramento models) and the new GFDL land model within the UW multimodel system. Initially, however, we will retain the set of models run at EMC.

Status: We have implemented the Catchment LSM (NASA/GSFC) in the UW multimodel system and completed its testing. The UW multimodel system can be accessed at: http://www.hydro.washington.edu/forecast/monitor/curr/conus.mexico/main_sm.multimodel.shtml. We are currently working on implementing the GFDL land model (Donner et al., 2011) and the Unified Land Model (ULM) (Livneh et al., 2011) into the multimodel system.

Task 3: Data set unification (Lead UW)

At the University of Washington, two data sets have been used. One is the historical NLDAS data set of Maurer et al (2002), which is for the period 1950-2000, at 1/8 degree spatial resolution. The other is an extension of the Maurer et al data set at ½ degree spatial resolution from 1915 through 2003. At EMC, extensions of the NLDAS real-time data set (initially from late early 2000s to present, more recently extended to include earlier data) were initially used. As the NARR data became available, EMC switched some analyses to the NARR period (1979 to near-current). CPC has used both NARR and a new CPC "unified" precipitation data set. There are advantages and disadvantages of all of the various data sets – reanalysis-based data sets like NARR include all forcing variables (including radiative) directly, whereas data sets like those developed by the University of Washington use index methods that relate downward solar and longwave radiation to the daily temperature range and average temperature, respectively.

We proposed to produce mappings and/or consistent extensions of the various data sets – for instance, we may produce an "extended NARR" data set that adjusts station-based methods to be consistent with NARR in the overlap period, and to use an extended data set (possibly to as early as 1915) for purposes of estimating the probabilities associated with drought indices.

Status: We have extended the Maurer et al (2002) dataset to the period 1915-2010 (August) at 1/16 degree resolution and finished testing the quality of dataset against the previous version of the Maurer et al. data (Figure 1). A publication (Livneh et al. 2012) is in progress to document this work. We have also compared forcings between the EMC multimodel system based on NLDAS and the UW multimodel system (Mo et al., 2012a).

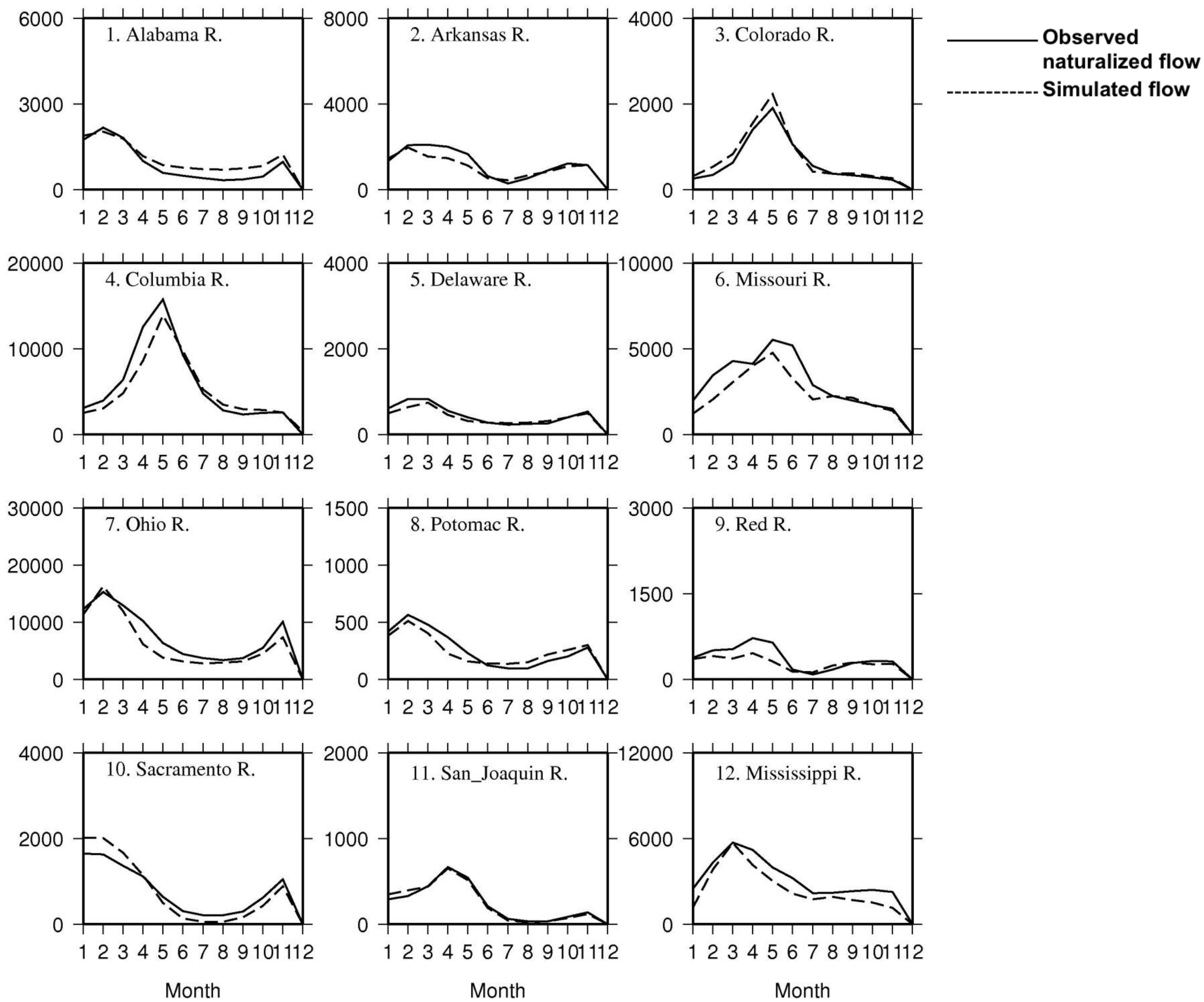


Figure 1: Mean monthly hydrographs over the period 1961-1990 from 1/16 degree derived data set of Livneh et al. (2012) for selected large U.S. river basins, with ordinate values in units of m^3/s. Simulated flows are denoted by dashed lines, while observed or naturalized flows are solid lines.

Task 4: Generation of drought index hindcasts and forecasts (Lead: PU)

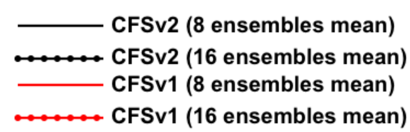
We proposed to implement within the CTB objective measures of drought that include ensemble predictions of drought on-set, severity and recovery, streamflow forecasts (including low flows), and operational CPC indices such as SPI and SRI.

Status: Princeton University is the lead for this task; UW does not have a major role.

Task 5: Assessment and verification studies (Lead: UW)

We proposed to work with our CPC and EMC collaborators to evaluate the forecast skill of the multi-model drought products. We also proposed, in particular, to coordinate closely with ongoing work by our CPC collaborator Mo in carrying out diagnostic and verification studies. Metrics currently being used to assess the Princeton seasonal hydrologic forecast system include ranked probability scores, brier score and root mean square error. We will use these and other verification approaches suggested by our collaborators.

Status: We have worked with Dr. Kingtse Mo to perform a verification analysis of NCEP's Climate Forecast System version-2 (CFSv2) in terms of its applicability to seasonal drought prediction (Figs. 2 and 3) (Mo et al., 2012b). This work is currently ongoing for other forecast dates in the year.



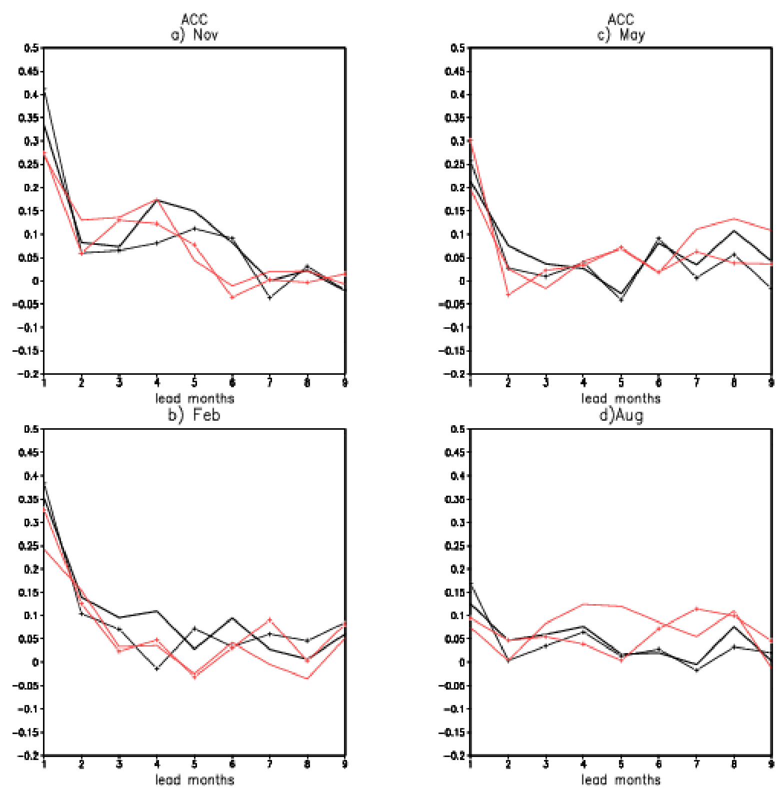


Figure 2: Anomaly correlation of Precipitation hindcasts over the contiguous United States as a function of the lead time for initial conditions in (a) October – November, (b) January – February, (c) April – May, and (d) July – August for hindcasts from the 8 member ensemble from CFSv2 (black), 16 member ensemble from CFSv2 (black dots), 8 member ensemble from CFSv1 (red line) and 16-member ensemble from CFSv1 (red dots).

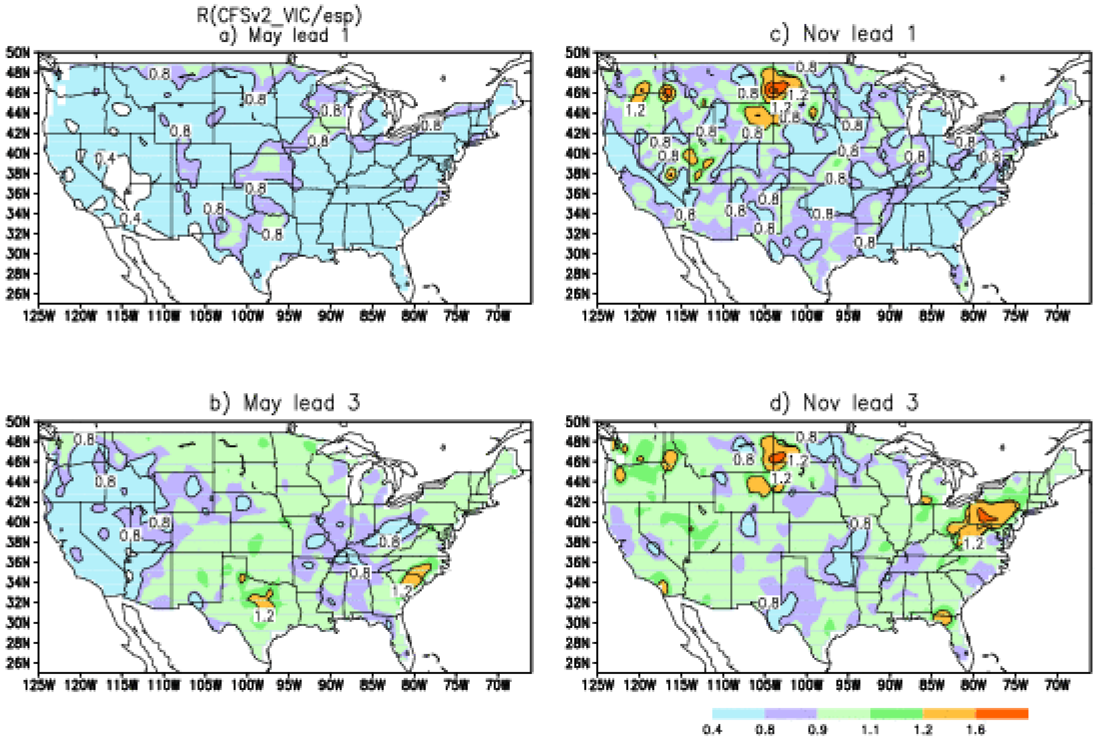


Figure 3: (a) Ratio of the RMSE of CFSv2 and ESP for soil moisture forecasts initialized in May at lead 1 month. Contour interval is 0.1, (b) same as (a), but at 3 months, (c)-(d) same as (a)-(b), but for hindcasts initialized in November (from Mo et al., 2012b).

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